WE CLAIM:

1. An optical vend-sensing system for control of a vending machine which has at least one mechanism arranged for initiating operation upon selection by a customer for vending an article into a vend space through which the article falls into a customer-accessible hopper, the vend space having a defined lateral width and a defined front-to-rear depth,

said sensing system comprising:

at least one emitter of electromagnetic radiation, and associated structure, arranged at one lateral extreme of said vend space to emit electromagnetic radiation in a broad plane ~~which~~ substantially completely covers the transverse cross section of the vend space below said at least one mechanism but above where said article, upon being vended, comes to rest in said customer-accessible hopper;

at least one electromagnetic radiation detector;

a collector body including at least one collector arranged at an opposite lateral extreme of said vend space to collect electromagnetic radiation reaching said at least one collector in said plane, substantially completely depthwise of said vend space, and for redirecting such collected electromagnetic radiation to said at least one electromagnetic radiation detector;

a machine control unit arranged for terminating operation of the respective at least one motor-powered mechanism; and

control circuitry operatively connecting said at least one detector with said machine control computer, and arranged for providing a signal for causing the machine control unit to complete a vend cycle of said respective at least one mechanism upon said at least one detector sensing that electromagnetic radiation reaching said at least one collector as a result of electromagnetic radiation emission by said at least one emitter has temporarily diminished by a predetermined amount.

2. The optical vend-sensing system of claim 1, wherein:

said at least one emitter of electromagnetic radiation is arranged to emit electromagnetic radiation predominately in the infrared part of the electromagnetic radiation spectrum.

3. The optical vend-sensing system of claim 2, wherein:

said associated structure comprises a diffuser ranked closely in front of said at least one emitter relative to said collecting body, for spreading electromagnetic radiation emitted by said at least one emitter into said plane.

4. The optical vend-sensing system of claim 3, wherein:

said at least one emitter comprises a plurality of coordinately operated emitters arranged in at least one row which extends front-to-rear, depthwise of said vend space.

5. The optical vend-sensing system of claim 1, wherein:

said at least one emitter comprises a plurality of coordinately operated emitters arranged in at least one row which extends front-to-rear, depthwise of said vend space.

6. The optical vend-sensing system of claim 5, wherein:

each said emitter is a light-emitting diode.

7. The optical vend-sensing system of claim 1, wherein:

said at least one electromagnetic radiation detector is disposed for receiving collected electromagnetic radiation collected by said at least one collector, from a direction which is substantially perpendicular to said plane.

8. The optical vend-sensing system of claim 7, wherein:

said at least one electromagnetic radiation detector is disposed below said at least one collector.

9. The optical vend-sensing system of claim 7, wherein:

said at least one collector comprises at least one parabolic mirrored surface provided on said collector body.

10. The optical vend-sensing system of claim 9, wherein:

said at least one detector comprises for each said parabolic mirrored surface, a photodetector disposed at an optical center of the respective parabolic mirrored surface.

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11. The optical vend-sensing system of claim 10, wherein:

each said photodetector is mounted on said collector body.

12. The optical vend-sensing system of claim 9, wherein:

said at least one collector comprises at least two collectors arranged side by side depthwise of said vend space.

13. The optical vend-sensing system of claim 12, wherein:

said at least one electromagnetic radiation detector is disposed below said at least one collector.

14. The optical vend-sensing system of claim 4, wherein:

said at least one electromagnetic radiation detector is disposed for receiving collected electromagnetic radiation collected by said at least one collector, from a direction which is substantially perpendicular to said plane.

15. The optical vend-sensing system of claim 14, wherein:

said at least one electromagnetic radiation detector is disposed below said at least one collector.

16. The optical vend-sensing system of claim 14, wherein:

said at least one collector comprises at least one parabolic mirrored surface provided on said collector body.

17. The optical vend-sensing system of claim 16, wherein:

said at least one detector comprises ~~for~~ each said parabolic mirrored surface, a photodetector disposed at an optical center of the respective parabolic mirrored surface.

18 . The optical vend-sensing system of claim 17, wherein:

each said photodetector is mounted on said collector body.

19. The optical vend-sensing system of claim 16, wherein:

said at least one collector comprises at least two collectors arranged side by side depthwise of said vend space.

20. . The optical vend-sensing system of claim 19, wherein:

said at least one electromagnetic radiation detector is disposed below said at lease one collector.

21. The optical vend-sensing system of claim 20, wherein:

each said emitter is a light-emitting diode.

22. The optical vend-sensing system of claim 1, wherein:

said control circuitry includes an adjuster for adjusting said predetermined amount.

23. The optical vend-sensing system of claim 1, wherein:

said control circuitry and said machine control unit are arranged for reducing effect on sensory of temporary diminishment of electromagnetic

radiation reaching said collector, of ambient electromagnetic radiation not emitted by said at least one emitter.

24. An optical sensor, comprising:

an elliptical reflector ring having an interior reflecting surface;

an emitter of electromagnetic radiation disposed proximate to a first focal point of said elliptical reflector ring;

a detector disposed proximate to the second focal point of said elliptical reflector ring, said detector having an electromagnetic radiation detecting element,

wherein electromagnetic radiation from said emitter is reflected by said reflecting surface of said elliptical reflector ring and focused substantially on said electromagnetic radiation detecting element, and said emitter and said detector reserve a space therebetween to permit objects to be detected to pass therethrough.

25. An optical sensor according to claim 24, further comprising:

a first dimple reflector disposed substantially at the first focal point of said elliptical reflector ring; and

a second dimple reflector disposed substantially at the second focal point of said elliptical reflector ring,

wherein said first dimple reflector redirects electromagnetic radiation from said emitter to enhance an intensity of electromagnetic radiation from said emitter in said space reserved between said emitter and said detector, and

said second dimple reflector redirects electromagnetic radiation incident thereon onto said electromagnetic radiation detecting element.

26. A vending machine, comprising:

an electromechanical dispensing unit having a plurality of product containment regions;

a payment and selection unit that is in communication with said electromechanical dispensing unit, wherein said payment and selection unit sends a signal to said electromechanical dispensing unit to dispense a selected product after a consumer has selected and satisfied payment for said selected product; and

an optical vend-sensing system disposed proximate to said electromechanical dispensing unit, said optical vend-sensing system being in

communication with said payment and selection unit and said electromechanical dispensing unit,

wherein said vend-sensing system comprises:

an emitter providing electromagnetic radiation substantially subtending a detection region through which an object to be detected will traverse,

a collector disposed in a path of said electromagnetic radiation and substantially subtending said detection region, and

a detector disposed proximate to said collector, said detector receiving substantially unattenuated electromagnetic radiation from said collector when said object to be ~~detected~~ is outside of said detection region, and receiving attenuated electromagnetic radiation from said collector when said object to be detected is in said detection region.

27. A vending machine according to claim 26, wherein said collector comprises an elliptical reflector ring having an interior reflecting surface,

said emitter is disposed proximate to a first focal point of said reflector ring,

said detector has an electromagnetic radiation detecting element disposed proximate to the second focal point of said reflector ring,

electromagnetic radiation from said emitter is reflected by said reflecting surface of said elliptical reflector ring and focused substantially on said electromagnetic radiation detecting element, and

said emitter and said detector reserve a space therebetween to permit objects to be detected to pass therethrough.

28. A vending machine according to claim 27, wherein said vend-sensing system comprises:

a first dimple reflector disposed substantially at the first focal point of said elliptical reflector ring; and

a second dimple reflector disposed substantially at the second focal point of said elliptical reflector ring,

wherein said first dimple reflector redirects electromagnetic radiation from said emitter to enhance an intensity of electromagnetic radiation from said emitter in said space reserved between said emitter and said detector, and

said second dimple reflector redirects electromagnetic radiation incident thereon onto said electromagnetic radiation detecting element.

29. A vending machine according to claim 26, wherein said collector has a reflecting surface that is a section of a parabolic surface, said reflecting surface of said collector reflecting at least a portion of said electromagnetic radiation substantially subtending said detection region to said detector.

30. A vending machine according to claim 29, wherein said collector has a flat reflecting surface that is substantially a planar reflecting surface,

said flat reflecting surface being inclined at an angle with respect to incident electromagnetic radiation from said electromagnetic radiation substantially subtending said detection region to reflect said incident radiation to said parabolic surface.

31. A vending machine according to claim 26, wherein said emitter provides pulsed electromagnetic radiation.

32. A vending machine according to claim 26, wherein said emitter provides continuous electromagnetic radiation.

33. A vending machine according to claim 26, wherein said emitter provides infrared radiation.

34. A method of detecting a dispensed object, comprising:

emitting electromagnetic radiation in a beam such that said electromagnetic radiation substantially subtends a detection region through which said dispensed object will traverse;

collecting electromagnetic radiation from said emitting and directing the collected electromagnetic radiation onto an electromagnetic radiation detecting element;

selecting a detection threshold that is exceeded when said object to be detected does not intercept said detection region and is not reached when said object intercepts said region; and

comparing a plurality of signals from said electromagnetic radiation detecting element, each at a different time, to said detection threshold.

35. A method of detecting a dispensed object according to claim 34, wherein said emitting electromagnetic radiation emits pulsed radiation.

36. A method of detecting a dispensed object according to claim 34, wherein said emitting electromagnetic ~~radiation~~ emits continuous radiation.

37. A method of detecting a dispensed object according to claim 34, wherein said selecting a detection threshold is a dynamic selection that compensates for variations in electromagnetic radiation in said detection region that are slow relative to a time interval for said dispensed object to traverse said beam of electromagnetic radiation.

38. An optical vend-sensing system according to claim 1, wherein said at least one mechanism for operation ~~upon~~ selection by a customer for vending an article is an electric motor-powered mechanism.

39. A vending machine according to claim 26, wherein said optical vend-sensing system has at least one automatic calibration mode of operation.

40. A method of detecting a dispensed object according to claim 35, wherein a pulse width of said pulsed radiation is selected during a calibration of said detecting a dispensed object.

41. A method of detecting a dispensed object according to claim 35, wherein said calibration is one of a group of calibrations consisting of

a full calibration,

a limit-less calibration,

a limited calibration, and

a calibration check,

said full calibration comprising resetting all stored system variables, initializing a pulse width to a predetermined minimum value, said pulse width being twice a detected width of said pulsed radiation, and increasing said pulse width by a preselected pulse width quantum until at least a first preselected number of consecutive pulses are received by said electromagnetic radiation

detecting element with a pulse width variance less than a first preselected variance limit,

said limit-less calibration comprising initializing said pulse width to a currently stored pulse width decremented by one said preselected pulse width quantum, and increasing said pulse width by said preselected pulse width quantum until at least said first preselected number of consecutive pulses are received by said electromagnetic radiation detecting element with a pulse width variance less than a second preselected variance limit,

said limited calibration comprising initializing said pulse width to said currently stored pulse width decremented by one said preselected pulse width quantum, and increasing said pulse width by said preselected pulse width quantum until at least said first preselected number of consecutive pulses are received by said electromagnetic radiation detecting element with said pulse width variance less than said second preselected variance limit, wherein a basis signal which is a compound light intensity signal combining ambient and excitation light is varied within a preselected basis signal variation range, and a strength of a pulse width modulation signal is varied within a preselected pulse width modulation signal variation range,

said calibration check signaling a proper operational status of a detection device used for said method of detecting a dispensed object upon receiving at least a second preselected number of consecutive pulses by said

electromagnetic radiation detecting element with a pulse width variance less than a third preselected variance limit, wherein said basis signal is varied within said preselected basis signal variation range, and said strength of said pulse width modulation signal is varied within said preselected pulse width modulation signal variation range.

42. A method of detecting a dispensed object according to claim 41, wherein said pulse width has a preselected ~~maximum~~ value.

43. A method of detecting a dispensed object according to claim 42, wherein said first preselected variance limit is smaller than said second preselected variance limit, and said second preselected variance limit is smaller than said third preselected variance limit.

44. A method of detecting a dispensed object according to claim 43, wherein said first preselected variance limit is about one microsecond, said second preselected variance limit is about two microseconds, and said third preselected variance limit is about three microseconds.

45. A method of detecting a dispensed object according to claim 42, wherein said predetermined minimum value of said pulse width is about sixteen microseconds and said preselected maximum value of said pulse width is about fifty microseconds.

46. A method of detecting a dispensed object according to claim 45, wherein said preselected pulse width quantum is about one microsecond.

47. A method of detecting a dispensed object according to claim 41, wherein said second preselected number of consecutive pulses is less than said first preselected number of consecutive pulses.

48. A method of detecting a dispensed object according to claim 41, wherein said first preselected number of consecutive pulses is about one-hundred and sixty, and said second preselected number of consecutive pulses is about sixty four.

49. A method of detecting a dispensed object according to claim 41, wherein said preselected basis signal variation range is from about 10%

less than to about 10% greater than a basis signal value stored in an immediately prior calibration.

50. A method of detecting a dispensed object according to claim 41, wherein said preselected pulse width modulation signal variation range is from about 10% less than to about 10% greater than a pulse width modulation signal value stored in an immediately prior calibration.

51. A method of detecting a dispensed object according to claim 41, wherein said limit-less calibration is performed upon powering up a detection device used for said method of detecting a dispensed object when said detection device has been off for longer than about five minutes.

52. A method of detecting a dispensed object according to claim 41, wherein said limit-less calibration is performed upon powering up a detection device used for said method of detecting a dispensed object when an ambient temperature has changed by at least about two degrees Fahrenheit relative to an ambient temperature recorded in a previous calibration.

53. A method of detecting a dispensed object according to claim 41, wherein said limited calibration is performed upon powering up a detection device used for said method of detecting a dispensed object when a time since the immediately preceding calibration is between about three minutes and about five minutes.

54. A method of detecting a dispensed object according to claim 41, wherein a full calibration is performed upon being selected during servicing of a detection device used for ~~said method~~ of detecting a disposed object.

55. A method of detecting a dispensed object according to claim 41, wherein said calibration check is performed immediately preceding dispensing said object.

56. A method of detecting a dispensed object according to claim 41, wherein one of a plurality of error signals is activated when a detection device used for said method of detecting a disposed object fails at least one calibration of said group of calibrations.

57. A method of detecting a dispensed object according to claim 56, wherein said plurality of error signals correspond to insufficient light, too

much light, no signal, a poor ~~quality~~ signal, a drastic environmental shift, and a fatal detector error, respectively.

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